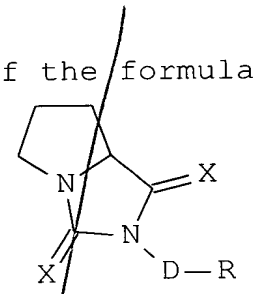
We claim:

1. A compound of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or a C_1-C_8 alkyl or alkenyl;

R is selected from the group consisting of hydrogen, phenyl, biphenyl, cyclopropyl, cyclobutyl, cyclopentyl, cycloheptyl, cyclooctyl, naphthyl, 1,2,3,4-tetrahydronaphthyl, indenyl, azulenyl, fluorenyl, anthracenyl, isoindolyl, indolinyl, benzofuranyl, benzothiophenyl, indazolyl, benzimidazolyl, tetrahydrofuranyl, tetrahydropyranyl, pyridyl, pyrrolyl, pyrrolidinyl, pyridinyl, pyrimidinyl, purinyl, quinolinyl, isoquinolinyl, tetrahydroquinolinyl, quinolizinyl, furyl, benzofuranyl, thiophenyl, imidazolyl, oxazolyl, benzoxazolyl, benzoxazinyl, thiazolyl, isoxazolyl, isotriazolyl, oxadiazolyl, triazolyl, thiadiazolyl, pyridazinyl, pyrimidinyl, pyrazinyl, triazinyl, trithianyl, indolizinyl, pyrazolyl, pyrazolinyl, pyrazolidinyl, benzopyranyl, thienyl, tetrahydroisoquinolinyl, cinnolinyl, phthalazinyl, quinazolinyl, quinoxalinyl, naphthyridinyl, pteridinyl, carbazolyl,

phenazinyl, phenothiazinyl, phenoxazinyl, and adamantyl;

wherein R may be optionally substituted with one substituent which is selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof;

wherein when R is hydrogen, D is a C_5-C_7 alkyl or C_5-C_8 alkenyl;

wherein when R is phenyl and D is a bond, R must be substituted with phenyl, hydroxyl, trifluoromethyl, C_2-C_6 straight or branched chain alkyl or alkenyl, C_3-C_4 alkoxy or C_2-C_4 alkenyloxy, phenoxy, or benzyloxy;

wherein when R is 4-trifluoromethylphenyl, both X substituents must be O.

2. The compound according to claim 1 that is selected from the group consisting of:

(7aS)-2-(1-Naphthyl)perhydropyrrolo[1,2-*c*]imidazole-1,3-dione,

(7aS)-2-(2'-Phenyl)phenylperhydropyrrolo[1,2-*c*]imidazole-1,3-dione,

(7aS)-2-(4-(Trifluoromethyl)phenyl)perhydropyrrolo[1,2-*c*]imidazole-1,3-dione,

2-benzyl-3-thioxo-2,5,6,7,7a-pentahydro-2-azapyrrolizin-1-one,

2-hexyl-2,5,6,7,7a-pentahydro-2-azapyrrolizine-1,3-dione,

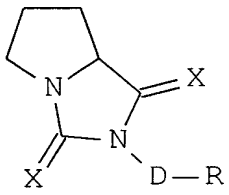
2-(2-ethyl)phenyl-2,5,6,7,7a-pentahydro-2-azapyrrolizin-1,3-dione,

2-(3-phenylpropyl)-3-thioxo-2,5,6,7,7a-pentahydro-

2-azapyrrolizin-1-one, and

2-(2-phenylethyl)-3-thioxo-2,5,6,7,7a-pentahydro-2-azapyrrolizin-1-one.

3. A pharmaceutical composition comprising an effective amount of a compound and a pharmaceutically acceptable carrier, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

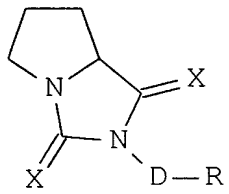
4. The pharmaceutical composition of claim 3, further comprising an additional neurotrophic factor.

5. The pharmaceutical composition of claim 4, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth

factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

6. A method of treating a neurological disorder in an animal, comprising:

administering to the animal an effective amount of a compound to stimulate growth of damaged peripheral nerves or to promote neuronal regeneration, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

7. The method of claim 6, wherein the neurological disorder is selected from the group consisting of

peripheral neuropathies caused by physical injury or disease state, physical damage to the brain, physical damage to the spinal cord, stroke associated with brain damage, and neurological disorders relating to neurodegeneration.

8. The method of claim 6, wherein the neurological disorder is selected from the group consisting of Alzheimer's Disease, Parkinson's Disease, amyotrophic lateral sclerosis, and Huntington's Disease.

9. The method of claim 6, wherein the neurological disorder is Alzheimer's Disease.

10. The method of claim 6, wherein the neurological disorder is Parkinson's Disease.

11. The method of claim 6, wherein the neurological disorder is amyotrophic lateral sclerosis.

12. The method of claim 6, wherein the neurological disorder is Huntington's Disease.

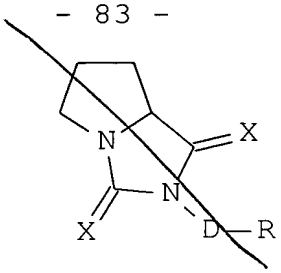
13. The method of claim 6, wherein the compound is non-immunosuppressive.

14. The method of claim 6, further comprising administrating an additional neurotrophic factor.

15. The method of claim 14, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

16. A method of stimulating growth of damaged peripheral nerves, comprising:

administering to damaged peripheral nerves an effective amount of a compound to stimulate or promote growth of the damaged peripheral nerves, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

17. The method of claim 16, wherein the compound is non-immunosuppressive.

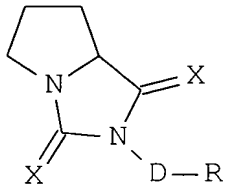
18. The method of claim 16, further comprising administrating an additional neurotrophic factor.

19. The method of claim 18, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

20. A method for promoting neuronal regeneration

and growth in animals, comprising:

administering to an animal an effective amount of a compound to promote neuronal regeneration, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

21. The method of claim 20, wherein the compound is non-immunosuppressive.

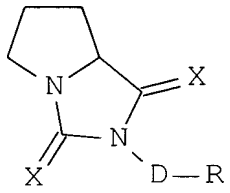
22. The method of claim 20, further comprising administrating an additional neurotrophic factor.

23. The method of claim 22, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active

truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

24. A method for preventing neurodegeneration in an animal, comprising:

administering to an animal an effective amount of a compound to prevent neurodegeneration, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

25. The method of claim 24, wherein the neurodegeneration is Alzheimer's Disease.

26. The method of claim 24, wherein the neurodegeneration is Parkinson's Disease.

27. The method of claim 24, wherein the

neurodegeneration is amyotrophic lateral sclerosis.

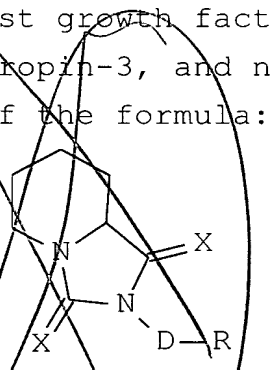
28. The method of claim 24, wherein the neurodegeneration is Huntington's Disease.

29. The method of claim 24, wherein the compound is non-immunosuppressive.

30. The method of claim 24, further comprising administrating an additional neurotrophic factor.

31. The method of claim 30, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

32. A compound of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or a C_1-C_8 alkyl or alkenyl;

R is selected from the group consisting of hydrogen, phenyl, biphenyl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, 1,2,3,4-tetrahydronaphthyl, indenyl, azulenyl, fluorenyl, anthracenyl, indolyl, isoindolyl, indolinyl, benzofuranyl, benzothiophenyl, indazolyl, benzimidazolyl, tetrahydrofuranyl,

tetrahydropyranyl, pyridyl, pyrrolyl, pyrrolidinyl, pyridinyl, pyrimidinyl, purinyl, quinolinyl, isoquinolinyl, tetrahydroquinolinyl, quinolizinyl, furyl, thiophenyl, imidazolyl, oxazolyl, benzopyranyl, thiazolyl, isotriazolyl, oxadiazolyl, triazolyl, thiadiazolyl, pyridazinyl, pyrimidinyl, pyrazinyl, triazinyl, trithianyl, indolizinyl, pyrazolyl, pyrazolinyl, pyrazolidinyl, thienyl, tetrahydroisoquinolinyl, cinnolinyl, phthalazinyl, quinazolinyl, naphthyridinyl, pteridinyl, carbazolyl, acridinyl, phenazinyl, phenothiazinyl, phenoxazinyl, and adamantyl;

wherein R may be optionally substituted with one substituent which is selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof;

wherein when R is hydrogen, D is a C_5-C_8 alkyl or alkenyl;

wherein when R is phenyl and D is a bond, R must be substituted with C_2-C_3 or C_5-C_6 straight or branched chain alkyl or alkenyl, C_3-C_4 alkoxy or C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, or amino.

33. The compound according to claim 32 that is selected from the group consisting of:

2-Benzyl-2,5,6,7,8,8a-hexahydro-2-azaindolizine-1,3-dione,

2-benzyl-3-thioxo-2,5,6,7,8,8a-hexahydro-2-azaindolizin-1-one,

2-(2-phenylethyl)-3-thioxo-2,5,6,7,8,8a-hexahydro-2-azaindolizin-1-one,

2-Heptyl-2,5,6,7,8,8a-hexahydro-2-azaindolizine-1,3-dione,

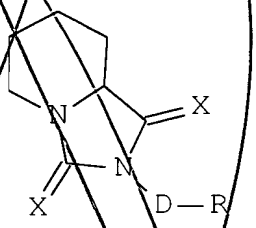
2-Octyl-2,5,6,7,8,8a-hexahydro-2-azaindolizine-1,3-dione,

2-(3-phenylpropyl)-3-thioxo-2,5,6,7,8,8a-hexahydro-2-azaindolizin-1-one,

2-hexyl-2,5,6,7,8,8a-hexahydro-2-azaindolizine-1,3-dione, and

2-Cyclohexyl-2,5,6,7,8,8a-hexahydro-2-azaindolizine-1,3-dione.

34. A pharmaceutical composition comprising an effective amount of a compound and a pharmaceutically acceptable carrier, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-

C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

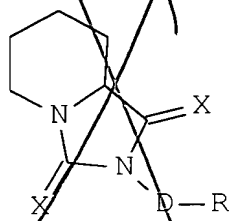
or a pharmaceutically acceptable salt, ester, or solvate thereof.

35. The pharmaceutical composition of claim 34, further comprising an additional neurotrophic factor.

36. The pharmaceutical composition of claim 35, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

37. A method of treating a neurological disorder in an animal, comprising:

administering to the animal an effective amount of a compound to stimulate growth of damaged peripheral nerves or to promote neuronal regeneration, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

38. The method of claim 37, wherein the neurological disorder is selected from the group consisting of peripheral neuropathies caused by physical injury or disease state, physical damage to the brain, physical damage to the spinal cord, stroke associated with brain damage, and neurological disorders relating to neurodegeneration.

39. The method of claim 37, wherein the neurological disorder is selected from the group consisting of Alzheimer's Disease, Parkinson's Disease, amyotrophic lateral sclerosis, and Huntington's Disease.

40. The method of claim 37, wherein the neurological disorder is Alzheimer's Disease.

41. The method of claim 37, wherein the neurological disorder is Parkinson's Disease.

42. The method of claim 37, wherein the neurological disorder is amyotrophic lateral sclerosis.

43. The method of claim 37, wherein the neurological disorder is Huntington's Disease.

44. The method of claim 37, wherein the compound is non-immunosuppressive.

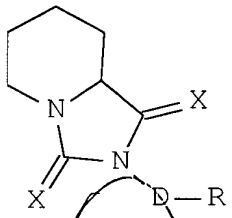
45. The method of claim 37, further comprising administrating an additional neurotrophic factor.

46. The method of claim 45, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived

growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

47. A method of stimulating growth of damaged peripheral nerves, comprising:

administering to damaged peripheral nerves an effective amount of a compound to stimulate or promote growth of the damaged peripheral nerves, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

48. The method of claim 47, wherein the compound

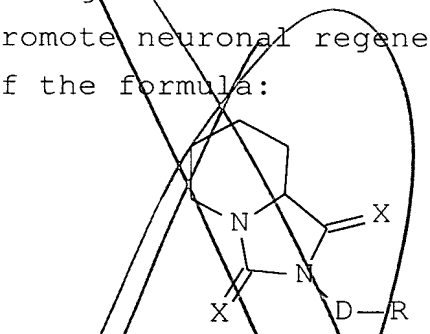
is non-immunosuppressive.

49. The method of claim 47, further comprising administrating an additional neurotrophic factor.

50. The method of claim 49, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

51. A method for promoting neuronal regeneration and growth in animals, comprising:

administering to an animal an effective amount of a compound to promote neuronal regeneration, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-

C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

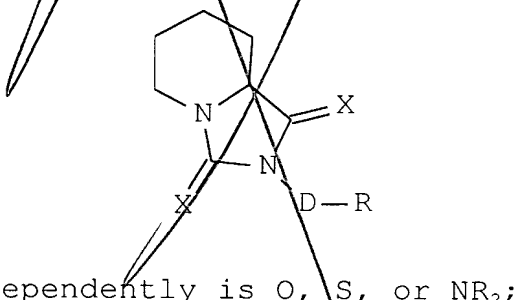
52. The method of claim 51, wherein the compound is non-immunosuppressive.

53. The method of claim 51, further comprising administrating an additional neurotrophic factor.

54. The method of claim 53, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

55. A method for preventing neurodegeneration in an animal, comprising:

administering to an animal an effective amount of a compound to prevent neurodegeneration, wherein the compound is of the formula:



where

each X independently is O, S, or NR_2;

R_2 is selected from the group consisting of cyano, nitro, hydrogen, C_1-C_4 alkyl, hydroxy, and C_1-C_4 alkoxy;

D is a direct bond or C_1-C_8 alkyl or alkenyl;

R is hydrogen, or an alicyclic or aromatic, mono-, bi- or tricyclic, carbo- or heterocyclic ring;

wherein R is optionally substituted with one substituent selected from the group consisting of hydrogen, halo, hydroxyl, nitro, trifluoromethyl, C_1-C_6 straight or branched chain alkyl, C_2-C_6 straight or branched chain alkenyl, C_1-C_4 alkoxy, C_2-C_4 alkenyloxy, phenyl, phenoxy, benzyloxy, and amino;

or a pharmaceutically acceptable salt, ester, or solvate thereof.

56. The method of claim 55, wherein the neurodegeneration is Alzheimer's Disease.

57. The method of claim 55, wherein the neurodegeneration is Parkinson's Disease.

58. The method of claim 55, wherein the neurodegeneration is amyotrophic lateral sclerosis.

59. The method of claim 55, wherein the neurodegeneration is Huntington's Disease.

60. The method of claim 55, wherein the compound is non-immunosuppressive.

61. The method of claim 55, further comprising administrating an additional neurotrophic factor.

62. The method of claim 61, wherein the additional neurotrophic factor is selected from the group consisting of neurotrophic growth factor, brain derived growth factor, glial derived growth factor, cilial neurotrophic factor, insulin growth factor and active truncated derivatives thereof, acidic fibroblast growth factor, basic fibroblast growth factor, platelet-derived growth factors, neurotropin-3, and neurotropin-4/5.

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